Current Research in Nutrition and Food Science Vol. **3**(2), 156-164 (2015)

Influence of Pre- Pregnancy Weight, Food Habits and Lifestyle on Gestational Diabetes

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http://dx.doi.org/10.12944/CRNFSJ.3.2.08

(Received: July 24, 2015; Accepted: August 15, 2015)

ABSTRACT

This study aimed to assess the influence of pre- pregnancy weight, food habits and lifestyle on gestational diabetes and identify the contributing factors. Using a case-control study methodology, a total of 102 women were selected by random sampling from a hospital. Anthropometric measurements were taken and information on somatic data, dietary intake and physical activity levels were collected by interviewing the subjects using a validated questionnaire and analysed the data by employing relevant statistical treatment. Subjects were classified as GDM women and control group based on their blood glucose levels. Of the women who participated in the study, majority of GDM women had a higher BMI (25.58 ±3.50 kg/m^2) than control group (24.02±3.18 kg/m^2). The number of women in obesity Grade I and Grade II in GDM women were high. Protein intake was lower and fat intake higher than the Recommended Dietary Intake (RDI) in both groups. Energy contribution from carbohydrates and protein was higher from carbohydrates and fat in both groups. Physical activity among these pregnant women was sedentary. Maintaining normal pre-pregnancy weight, dietary habits and physical activity schedule as prescribed before pregnancy and early screening for GDM during pregnancy to initiate intervention will prevent gestational diabetes mellitus and its complications.

Key words: Gestational Diabetes Mellitus, Macrosomia, Hyperbilirubinemia, Respiratory Distress Syndrome, Polycythemia, Shoulder Dystocia, Hypoglycaemia, Hypocalcemia.

INTRODUCTION

Gestational diabetes mellitus is a common disorder affecting 1-14 % of all pregnancies[1]. The incidence of GDM is increasing with the increase in obesity among women of child bearing age[2]. Children born to women with GDM are more likely to be obese and have impaired glucose tolerance in childhood and early adulthood (1). They have a higher risk of macrosomia, trauma, and shoulder dystocia, hypoglycaemia, hypocalcemia, hyperbilirubinemia, respiratory distress syndrome and polycythemia. Among GDM women the risk type 2 diabetes or recurrent GDM is higher in future. Some recent data suggest an increased risk of cardiovascular disease[3].

The risk factors for the onset of GDM are adiposity and advanced maternal age, family history of type 2 diabetes and history of GDM[4]. In the past efforts to identify the risk factors for GDM have increased because of the increase in the prevalence of diabetes and obesity worldwide[5].

There are studies which suggest dietary factors like the type of carbohydrate and fat intake may be more relevant to increase the risk of glucose intolerance than the total amount of these nutrients[5]. Another study states that lower plasma Vitamin C and Vitamin D levels are significantly associated with increased risk of GDM[7]. However, studies that indicate that there is an association between dietary factors and risk of developing GDM have recently

emerged[6]. Thus, it is difficult to conclude the role of dietary factors during pregnancy in the development of GDM[5]. Whereas, the risk of Pre-pregnancy diet in the development of GDM was higher in those women who had a higher intake of red meat, processed meat, refined grain products, sweets and pizza[5]. Pre-pregnancy intake of higher amount of dietary fibre had significantly reduced the risk of GDM[6]. In contrast, a higher glycaemia load was associated with the risk of development of GDM[8].

Available data from the clinical studies suggest that physical activity in non pregnant women influence glucose homeostasis through its effect on insulin sensitivity and secretion[5] Increase in habitual physical activity had an effect on glucose tolerance and potentially decreased the risk of DM[9]. Studies on effect of physical activity on pregnant women are limited. The definitions of intensity, amount, and type of physical activity which will vary considerably, due to which comparison between studies is difficult[5]. Moreover, there are studies available which state that the risk of GDM decreases with the increase in the duration, intensity and physical activity[5]. Women with gestational diabetes mellitus have moderate to high risk of type 2 diabetes in the first several years postpartum[10].

Medical nutrition therapy for gestational diabetes mellitus aims to meet the maternal, foetal nutritional needs and maintain optimal glycaemic control. Intense nutrition therapy potentially benefits the mother and the child[11]. Studies have reported that vigorous physical activity before pregnancy and continuation of activity during pregnancy will reduce the risk of developing GDM[12]. The aim of the study was to assess the influence of pre-pregnancy weight, food habits and lifestyle on gestational diabetes.

Materials and Methods

A case-control descriptive and analytical study was conducted between July 2012 to July 2014 in Bangalore district of Karnataka. Subjects were recruited from the antenatal clinic of Apollo Hospital, a multispecialty hospital from urban part of the district between the age group 20-39 years. This study was carried out after obtaining the ethics committee approval in Apollo Hospital, Bangalore and in University of Mysore, Mysore. A total of 102 pregnant women were included for the study based on the willingness to participate. After recruiting the subjects for the study, pre-pregnancy anthropometric measurements, height and weight was recorded as per memory of the subjects and medical records. Body mass index (BMI; The weight in kilograms divided by the square of the height in meters) was calculated using the pre-pregnancy anthropometry and Asia pacific guideline cut-offs of BMI[14]

Subjects were screened in the fifth month, at 20 weeks of gestation using International Association of Diabetes in Pregnancy Study Group (IADPSG) criteria; OGTT was performed by administering 75gms of glucose after 12 hrs of fasting as per IADPSG guidelines[13]. The criteria of diagnosis of OGTT by IADPSG is as follows: subjects with blood sugars levels higher than 92 mg/dl in fasting and 153mg/dl after 2hrs of consuming 75 grams were identified based on these plasma concentrations met or exceeded to the thresholds as GDM women and control group. All subjects who met the inclusion criteria were included and those women who did not were excluded. A pretested questionnaire was used to interview the subjects to elicit information for data collection.

Data collection

Data regarding the subjects' background characteristics, personal and family medical history, lifestyle habits and behaviours, and course of pregnancy were collected by face-to-face interviews. The collected data included details like age, occupational status, education level, socio economic status, family history of co-morbidities, morbidity status of the subject, Gynaecology history, previous pregnancy complications, 24 hr dietary recall during pregnancy, physical activity level and details about any dependencies like alcohol consumption and smoking.

Dietary recall

Dietary data was collected and analysed using a 24 –hour diet recall questionnaire. Subjects were asked to recall foods taken over the past 24 hours using household measures relevant to Indian cuisine (serving bowls of various sizes, spoons or ladles) to assess the portion size. These food items were further converted to the raw food items and nutritive value was calculated. Data collected

included information on current food frequency, dietary pattern and food habits. The data from 24hr recall were analysed and nutritive value was calculated using the Indian food composition tables[15,16,17]. The regularity of intake and distribution of caloric and carbohydrate intake among meals and snacks throughout the day were determined.

Nutrient recommendations for each individual was calculated considering the pre-pregnancy weight (underweight, normal, overweight, or obese) and amount of weight gain during pregnancy (within normal range or excessive) according to the recommended dietary intake (RDI) using Indian food composition tables[15, 16, 17].

Calorie recommendations as per ICMR was 35 kcals/kg body weight with additonal 350 calories for pregnancy(18) these recommendations can be modified further for each patient based on weight gain and blood sugar control. Protein requirement was calculated as 1g/ kg body weight and an additional 0.5g /day for pregnancy in the first trimester, 7g/ day for pregnancy in the second trimester and 23g/day in the third trimester, visible fat recommendation was 30gms/d in addition invisible fat 30gms/day (saturated fat1/3 rd of total fat intake)[18]. Carbohydrate requirement was calculated as per the ratio, 50% of the total calories and converted into grams for comparison between RDI and intake.

The carbohydrate: protein: fat ratio was calculated according to the ICMR guidelines for pregnancy in the control group and GDM women as 50: 30: 20, 50% of the total calories from carbohydrates (more of complex carbohydrates), 30% of the total calories from fat and 20% of the total calories from protein[18]. One recent study indicated that consuming carbohydrates at 55% of calories vs. 40% didn't change the need for insulin in women with GDM and didn't affect pregnancy outcomes[19]. In fact, additional energy intake during pregnancy is a major requirement to meet up the increasing demands of pregnancy and the increase in BMR, reduction in physical activity will not account for the maternal and foetal energy requirements[20].

Physical activity levels assessment

The subjects were asked to record the daily physical activities in terms of type and duration (in hours and minutes) for three consecutive days in case of non working subjects and two consecutive

Table 1: Descriptive socio-demographic characteristics of the subjects (n=102)

	GDM women n=51 Mean(±SD)	Control subjects n=51 Mean(±SD)	p value
Age (yrs)	29.05(±3.55)	28.49(±3.54)	0.420
Age Menarche(yrs)	13.55(±1.22)	13.44(±1.19)	0.7749
Gestational age(weeks)	21.47(±1.11)	22.14(±1.2)	0.004*
Height(cms)	157.4(±6.77)	159.1(±5.66)	0.186
Weight (kgs)	63.41(±9.84)	60.75(±8.65)	0.150
BMI (kg/m^2)	25.58(±3.50)	24.02(±3.18)	0.019*
	Mean n (%)	Mean n (%)	
Under weight		2(3.92%)	
Normal	13(25.5%)	19(37.25%)	
Overweight	8(15.7%)	14(27.4%)	.057
Obesity Grade I	24(47.1%)	14(27.4%)	
Obesity Grade II	6(11.76%)	2(3.92%)	
Family history of Diabetes	32(62.7%)	20(39.2%)	0.017*
Employed	29(56.9%)	29(56.9%)	1.000
Home makers	22(43.1%)	22(43.1%)	

*statistically significant

working days and one Sunday in case of working subjects. From the data obtained, similar activities performed in 24 hours were grouped. For each group, energy cost of activity is as per the study methodology[21]. The time spent on each group of activities was then multiplied by the energy cost of that activity (kcal/ kg body weight/hour). The energy cost of physical activities in a day was then totalled up. The same procedure was adopted for calculating the energy cost of physical activities for each of the three days. To adhere to the normal practices of presenting the energy cost of physical activities per day, the average of three consecutive days was calculated and the data was utilised for the study. Physical activity level and energy expenditure calculation was done using the WHO/FAO/UNU equation.

Statistical analysis

Data was analysed using SPSS statistics version 16.0. Mean and standard deviation were calculated for data pertaining to socio-demography, anthropometry, dietary intake and energy expenditure using t- test statistical significance testing between the two groups. The level of significance was set at $p<0.05$ for all analyses (two tailed).

RESULTS

A total of 102 pregnant women participated in the study were drawn from a single multispecialty hospital.

Table 2: Macro nutrient intake and RDI of the subjects, comparison of macronutrients intake between the two groups, contribution of calories from macronutrients to the total calories, energy expenditure and deficit of the subjects

Macronutrients	GDM women Mean ±SD		P value	Control group Mean ±SD		p value
	Intake	RDI		Intake	RDI	
Energy(Kcals)	1844±304	1977±219	0.165	1968±297.61	1930±269	0.85
Protein(gms)	57 ±11	70.4±9.8	0.001*	58±8.50	67.7±8.6	0.00001*
Fat(gms)	67.50±17	60	0.0031*	69±16	60	0.00039*
CHO(gms)	239±46	241.9±30.7	0.73	265±36	233.6±27.0	0.00001*

Macronutrients	GDM Women Mean ±SD Intake	Control Group Mean ±SD Intake	p value
Energy(Kcals)	1844(±304)	1968(±297.61)	0.04*
Protein(gms)	57 (±11)	58(±8.50)	0.800
Fat(gms)	67.50(±17)	69(±16)	0.746
CHO(gms)	239(±46)	265(±36)	0.002*
Contribution of calories from macronutrients to the total calories			
CHO kcals)	957(±185)	1060(± 145)	0.002*
Protein (kcals)	229(± 44)	231(± 44)	0.799
Fat (kcals)	608(±156)	617(± 145)	0.746
Energy expenditure and deficit of the subjects			
Energy expenditure (kcals)	2067(±156)	2016(±177)	0.630
Energy deficit (kcals)	-223(± 365)	-98 (± 328)	0.126

RDI-Recommended Dietary Intake, GDM- Gestational Diabetes Mellitus

*statistically significant $p<0.05$

Socio demographic characteristics of study population

As shown in Table 1, the mean age of GDM women and control group was 29.05 y ± 3.55 and 28.49 y ±3.54, age of menarche 13.55y ±1.22, 13.44y ±1.19, gestational age of the subjects was 21.47(±1.11) weeks and 22.14(±1.2) weeks respectively and BMI was 25.58 kg/m^2 and 24.0 kg/m^2 respectively. Pre Pregnancy weight was compared and the control group had a higher percentage of women with normal body weight than the GDM women 37.25% and 25.5%, overweight subjects were 15.7% and 27.4% in GDM women and the control group respectively. Similarly, among GDM women, women falling in obesity category Grade I and II, were more than the control group 47.1% and 11.76% respectively. A difference is observed between the two groups, which is statistically not significant (p= 0.570, p > 0.05). The observation indicates that it is crucial to attain adequate pre-pregnancy weight and weight gain to experience normal pregnancy and reduce the risk of complications like abnormal birth weight babies.

In GDM women a higher percentage of women had family history of type 2 diabetes when compared with the control group, 62.7% and 39.2% respectively, whereas, the percentage of women without family history of type 2 diabetes were higher in the control group, of 37.3% and 60.8 % respectively, this difference was significant statistically (p< 0.05), indicating that presence of family history of Type 2 diabetes is one of the risk factors for the onset of gestational diabetes.

In this study occupational status did not seem to influence the occurrence of GDM as the number of subjects employed and homemakers were equal in both groups, 56.7% and 43.1% respectively, therefore, occupational status of these pregnant women is not a significant contributing factor (p>0.05), for the onset of gestational diabetes.

Dietary intake

Table 2, depicts macro nutrients intake and RDI of the subjects, comparison of macronutrient intake between the two groups, contribution of calories from macronutrients to the total calories, energy expenditure and deficit in the subjects. This study reveals that energy intake was lower than the RDI in GDM women, 1844.43±304.3kcals, where as in the control group it was higher than the RDI 1968.29±297.61kcals, corresponding to 93% and 102% of the Recommended Dietary Intake (RDI) respectively. The difference between the intake and RDI among the subjects was not statistically significant (p>0.05).

Protein intake appeared to be low compared to the RDI, 57±11gms and 58±8.50gms, corresponding to 81% and 85% of RDI respectively, difference was significant between the intake and RDI

Table 3: Time allocation and Energy expenditure pattern of the subjects

Activity	GDM		Control		p-value
	Time(min) Mean(SD)	Energy(kcals) Mean(SD)	Time(min) Mean(SD)	Energy(kcals) Mean(SD)	
Household	285(±93)	484(±156)	267(±69)	454(117)	0.271[a]
Personnel	160(±47)	208(±61)	157(±39)	204(±50)	0.731[a]
Commuting	18(±23)	55(±69)	24(±28)	72(±83)	0.409[b]
Office work	211(±247)	239 (±237)	239(±237)	404(±400)	0.709[b]
Recreation	248(±154)	498 (±309)	223(±150)	449(±301)	0.417[a]
Rest & Sleep	502(±61	547 (±67)	492(±46)	536(±50)	0.358 [a]
Child care	17(±32	36(±67)	39± (46)	81(±97)	0.008[b]
combined		2067		2016	

a. p value derived by ' t' test

b. p value derived by Mann Whitney U test.

in both groups (p<0.05) Among GDM women and control group subjects fat intake 67.50±17gms and 69±16gms respectively was significantly exceeding the RDI (p<0.05), corresponding to 113% and 115% of the total fat (visible and invisible fat), where as carbohydrate intake 239.31± 30.7gms in GDM women, was adequate when compared with the RDI, which was statistically non-significant(p>0.05), it was found to be significantly higher than the RDI(p<0.05) in the control group 265±36gms, corresponding to 99% and 113% of the RDI respectively .

Comparing the macronutrient intake between the two groups reveal that in the control group energy, protein, carbohydrate and fat intake was higher than GDM women, the difference was significant statistically only for energy and carbohydrate intake (p<0.05). Energy contribution to the total calories from carbohydrates was 52% and 54% in GDM women and control group respectively; from protein it was 12% and 11.7% respectively and from fat 32.9% and 31.3 % respectively. It was found that calorie contribution from carbohydrates and fat to total calories was higher, whereas, from protein it was lower than the recommendations.

It was also observed that energy expenditure among the subjects in both the groups was higher than energy intake, the difference was not significant statistically (p<0.05). Similarly, the difference in energy deficit between the groups was also not statistically significant (p>0.05).

Physical activity assessment

Table 3, depicts time allocation and energy expenditure of GDM women and the control group.

Time allocation and energy expenditure was calculated for activities like household work, personnel work, commuting, office work, recreation, rest & sleep and child care and compared between the groups. The findings of the study shows that the time allocated and energy expended in both groups for the household work, personnel work, recreation, rest and sleep was lesser in the control group than GDM women, p=0.271, p= 0.721, p= 0.417, p = 0.358 respectively which is not significant statistically p>0.05. In contrast, time allocated and energy expended for commuting, office work and child care was higher in the control group compared to GDM women, p= 409, p= 0.709, p=0.008 respectively, indicating that the difference is significant only for time allocated and energy expended for child care between the two groups (p < 0.05).

DISCUSSION

The present study aimed to investigate the impact of weight, food habits and lifestyle on gestational diabetes. Obese and overweight women are at a greater risk for the onset of gestational diabetes and presence of family history of Type 2 Diabetes increases the risk by multiple folds. Studies indicate that pre-pregnancy weight is an indicator for adverse maternal and foetal outcome. Being overweight and obese increases the risk of hypertension, gestational diabetes, foetal macrosomia and the incidence of assisted vaginal deliveries and caesarean deliveries. To ensure a better outcome of pregnancy it is important to maintain normal body weight before pregnancy[22]. Maternal obesity is also known to increase the risk of childhood obesity and diabetes in the off springs[1]. In addition to normal BMI recommendations, it is also important to have adequate gestational weight gain which has substantial impact on maternal health and would lead to better obstetric management[23]. The percentage of women having higher body weight and the number of women categorized into obesity grade I and grade II were higher in GDM women than the control group, increasing the incidence of gestational diabetes in these women. A comparison of BMI between the groups has demonstrated that pre pregnancy weight management decreases the risk of gestational diabetes in women[24]. In this study majority of subjects in obesity grade I and grade II were in the age groups 16-20 years and 21-25 years respectively, demonstrating that increase in age is not directly proportional to the onset of gestational diabetes. Above the age of 30 years the risk of gestational diabetes is higher[25].

Family history of diabetes is the predisposing factor for the onset of Gestational Diabetes[26]. However, presence of family history of type 2 diabetes increases the risk of GDM by three folds[27]. Similarly, the outcome of this study also states that presence of family history of type 2 diabetes has increased the incidence gestational diabetes in these subjects.

Maternal food intake during pregnancy, especially in the second trimester was associated with a risk of abnormal glucose metabolism later in pregnancy[28]. Among GDM women protein and fat intake differ significantly from the RDI, while, protein, fat and carbohydrate intake differ significantly from RDI in the control group women. Macronutrient intake was found to be higher in the control group than GDM women, indicating that control group subjects had better food intake than GDM women. The concern to maintain normal blood glucose levels might have led to this observation. In both the groups' contribution of calories from carbohydrates and fat was higher than the recommended percentage, whereas contribution from protein was lower than the recommended percentage. The difference in energy intake and expenditure was significant and was indicating a negative energy balance among these subjects. This observation might be because women before and during pregnancy are aware and conscious about the additional nutritional requirements and were attempting to meet up the recommendations[29].

The percentage of women working and non working were equal in both groups and the type of occupation in which these women were involved was more sedentary in nature to impose any risk of GDM in this study.

Energy expenditure and time allocation for all the activities within 24hrs was calculated between the two groups, it was found that time allocated and energy expended between the two groups was significant for child care ($p<0.05$). This study demonstrates that women are more sedentary during pregnancy and do not have a schedule for physical activity, which is similar to the study that states there is decrease in the intensity of physical activity and preferred more sedentary activities like household activities, recreation, rest and sleep[30]. Moreover, lifestyle intervention reduces the prevalence of gestational diabetes and also has a good impact during pregnancy in reducing the risk of preeclampsia[31, 32, 33]. Pregnant women do not indulge in the recommended levels of physical activity despite the well known benefits of it, because of feeling sick during pregnancy, low energy levels and lack of time, the factors that can facilitate physical activity in these women is by creating awareness and educating them about the benefits, family support is required and also making the activities more enjoyable[34]. In addition to these factors there are more barriers like concern of safety of the unborn baby among these women which is preventing them from being physically active[35]. Therefore, a more detailed and intense physical activity assessment about the duration of activity, intensity, nature of activity is needed to relate the impact of physical activity intervention in preventing the onset of gestational diabetes and also to control the symptoms in known subjects.

The results of the present study indicate that women diagnosed with GDM during pregnancy had a higher pre-pregnancy weight and BMI, presence of family history of Type 2 diabetes was higher in GDM women compared to the control group. Although the mean carbohydrate intake among GDM group was adequate, low protein, high fat diet and a higher percentage of calorie contribution to the total calories from carbohydrates than the recommended percentage are the factors that might have contributed for the onset of gestational diabetes. Lifestyle was sedentary among these women; hence, the emphasis is on physical activity levels, because it is known to be beneficial and safe during pregnancy. The recommendations are, maintaining normal pre-pregnancy weight, dietary habits and a regular physical activity schedule as recommended during pregnancy would prevent adverse pregnancy outcome. It is recommended that all pregnant women in future are screened early for GDM, especially those women in the risk category, leading to early diagnosis of gestational diabetes, facilitating early intervention to prevent the complications. To strongly recommend early screening more research in future with a larger sample size in a pregnancy cohort is the prerequisite.

ACKNOWLEDGEMENTS

The authors of the study wish to thank the participants for the time and cooperation extended to conduct the study.

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